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ABSTRACT

Elusive developmental processes are most often examined in the context of the philosophic problem of scientific determinism. The Markov process model, enhancing a probabilistic viewpoint for the explanation of developmental data, should be restricted. Attention should be focused on the immediate context and situational setting of a subject. The situational perception of a subject cannot be divorced from a subject's active reconstruction of past experiences nor separated from cyclic phenomena and external regularities. Obligatory and optional features of a task a subject performs are viewed as a function of the immediate contextual situation. Examples center on the developmental processes of a child. (BJG)

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# RESEARCH MEMORANDUM

## SOME INGREDIENTS FOR CONSTRUCTING DEVELOPMENTAL MODELS

Roy Freedle

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# SOME INGREDIENTS FOR CONSTRUCTING DEVELOPMENTAL MODELS[1]

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We can become profoundly discouraged by our inability to describe not only the necessary and sufficient conditions for development to occur, but also our inability to give a detailed account of the process itself by which this transformation from one stage to another is carried out. It is with some relief to note that several older sciences are plagued by similar limitations. Thus we find that evolutionists cannot predict when a new species will emerge nor what it will look like when it does emerge; also they cannot tell us how new species manage to arise almost instantaneously. In a related vein, chemists are now struggling to describe the minute steps by which high-speed chemical changes occur. The chemists probably can state necessary and sufficient conditions for their reactions to occur but they are still hard at work describing the minute processes by which the substeps are carried out. I mention these presumed facts only to remind us that there is nothing peculiar about our state of ignorance in describing developmental change nor is there any reason to be embarrassed by wide-ranging speculations about the kinds of models we think may be important in guiding our thinking on developmental change. What I shall outline below are three broad concerns that I find personally important in discussing development: (1) whether developmental theory has a need for probabilistic aspects in model construction or not, (2) whether

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[1]I would like to thank Irving Sigel for a critical reading of this paper.

developmental theory should be sensitive to situational constraints, and (3) whether there is a need for a separate analysis of task requirements and another analysis of the developing organism's ability to meet the obligatory features of the task.

Probabilistic considerations. Implicit in the above comments about necessary and sufficient conditions for change to occur is the philosophic problem of scientific determinism. If we frame our developmental model so that we require all uncertainty of change to be accounted for by stating algebraic conditions for transitions to occur, then we have, whether we realize it or not, committed ourselves to a nonprobabilistic model of development. This may or may not be correct. If probabilistic indeterminacy is present in some developmental changes, then allowing for this possibility will alter the kinds of models that we attempt to construct. Indeed, some months ago I planned to present for these meetings a stochastic Markov process model so as to account for moral development data. My quantitative focus just that brief time ago stemmed from a belief in the correctness of a probabilistic viewpoint for explaining much developmental data. While I now seek to question this viewpoint there is a sense in which uncertainty always enters into developmental data--it has to do with errors of measurement. For example errors in assigning a child to one of several developmental stages will, if we get fussy enough, force us to graft onto any algebraic (all-or-none) model a probabilistic process that accounts for errors in assigning subjects to stages. There are other levels of a developmental model that may or may not require probabilistic mechanisms to operate--for example, accounting for why the same person in repeated presentations will sometimes be correct and sometimes incorrect in responding to what is (or what seems to be) an identical situation. This type of uncertainty

within the individual being tested or observed has occurred often enough that other theorists have given it a name--decalage. Do we wish to explain this variance by introducing probabilistic assumptions somewhere in our developmental model or do we wish to explain it by invoking algebraic criteria by which we attempt to capture what was unique about each response which the subject made? It's a hard choice to make and it's a critical choice since it will affect the ways we theorize about developmental transformations. I will touch upon this issue again later.

Let me return to the Markovian model I referred to earlier so as to give you a taste of why I began to question whether this type of modeling necessarily clarifies developmental transformations. To make a long story short I got what can be regarded as a good fit of model to data. The data incidentally were Kohlberg's (1971) data on moral development obtained for the U. S. and Great Britain for several socioeconomic and age levels. The only piece of this model that I wish to comment on at this time is the use of a construct of a "critical moral event" which I was forced to invent so as to explicate the psychological significance of taking the Markovian transition matrix of probabilities to higher 'powers.' (See Freedle & Lewis, 1971, for examples of Markovian theory.) With the passage of time the number of critical 'events' had to increase: this was reflected in the fact that older groups of subjects required a higher power of the matrix to fit their data than did younger groups of subjects. This assumption plus another probabilistic one allowed me to fit most of the data reported by Kohlberg for the two countries and the several socioeconomic and age groups. The singularly important question though is what did I learn about the developmental process of moral development from having applied this stochastic theory to group data? The sad truth is that I learned very little,

or more accurately, I learned that from fitting grouped data I could say nothing important about the internal mechanisms and their transformations which elevated the individual from one stage to a higher stage. Looking at this from another point of view, I can now say that while it may be appropriate to postulate probabilistic mechanisms so as to account for the properties of grouped data, and while knowing the parameters of such populations may have its uses, one should not confuse this type of modeling group data with an explication of the cognitive processes within an individual that undergo change. This is not to say that other quantitative theorists should eschew Markovian models in developmental theory--it only means to point out that my particular use of Markovian theory for the moral development data had a very restricted outcome with respect to clarifying individual development. This realization led me to become more cautious in acceptance of probabilistic models of development.

To sum up the first point, developmental theorists implicitly or explicitly commit themselves to a choice between determinacy in developmental description as opposed to indeterminacy. Given the latter choice, there are at least three 'levels' at which indeterminacy can operate: (1) measurement errors in classifying responses by their stage characteristics, (2) variation in responses under experimentally 'identical' conditions, and (3) distributional variation resulting from considering the group characteristics of individuals classified by age, sex, etc. A particular probabilistic model may implicate any or all of these three levels.

Situational constraints. A second major issue for consideration in developmental theory construction is the following: How much of the situational setting in which behavior occurs must be taken into account before the experimenter or theorist assigns the observed person to a developmental stage;

and, in related fashion, how much of the current situational setting influences the subject's current behavior?

The second part of this issue may sound redundant but it isn't as I shall attempt to show. Before doing so, let's first consider why it may be important to study situational setting. This concept has been used increasingly in various developmental accounts. For example, Lois Bloom (1970) has argued that immediate context is necessary to separate out the several meanings of what seems on the surface to be the same utterance of a child. Situational setting has been shown by Lewis and Freedle (1973) to influence the transitional probability of mother-infant vocalization interactions when the infant is only 3 months old. Aebli (1973) has employed situational context in experimental settings to account for decalage effects in general developmental theory.

If one grants that the concept of the situation has explanatory value, one must at the same time admit to a certain inadequacy in defining just what is meant by a situation. Let's examine this problem. Suppose I ask you to give a situational description of what's happening right now in this conference room. Someone may define the situation by the following description: (1) a talk is being delivered, or (2) a developmental talk is being delivered by one person in the morning to an audience of n persons, or (3) a segment of a developmental talk is being given at the University of Michigan by one person with k other potential speakers listening in while a group of n persons in the audience shift about in restive fashion, and so on. These examples, while arranged in order of increasing specificity (both with regard to the mentioning of supposedly important features of time, place, and momentary composition of social structure) need not have been so ordered. The fact that all of

them may be correct descriptions of the 'situation' raises the issue of how much of the setting and how long a duration of time needs to be implicated in trying to define any situational setting. Perhaps the answer is: the definition is relative to what one's scientific purposes are and relative to what the subject's momentary goals are. Thus if one's theory says that discrimination among situations x, y, and z are the only important discriminations, then an adequate situational definition with respect to such a theory would be one which allows for an unambiguous categorization with respect to alternatives x, y, and z. Some other theory which requires a different categorization system may find the same definitions inadequate. This way of looking at the problem suggests that there is no single way to completely define a 'situation' since the same objectively recorded behaviors may simultaneously satisfy many different definitions.

The related problem of trying to define how the experimental subject perceives the situation is of course closely tied to which categories a particular theorist thinks is relevant; but the subject's own situational perception carries a subtle problem along with it that carries us back to the first problem area, namely, that of probabilistic indeterminacy. Let me clarify this.

Recent accounts of human perception suggests that perception is not a passive consequence of stimulus input but rather an active reconstructive process that may employ cognitive strategies (see Neisser, 1967; for an account of perceptual strategies in linguistic perception see Bever, 1970). We can speculate that the subject's perception of what situation it finds itself in may also depend upon active reconstruction based upon past experience. The particular cognitive strategies which one employs to recognize a current situation may be either probabilistically chosen or algebraically determined.

The choice which a theorist makes will again affect the whole conception of developmental changes in situational perception.

But if we grant the importance of situational context as one contributor to clarifying our understanding of development, we still need to analyze the notion of 'situation' to distinguish possibly different classes of features which in turn lead to different categories of situations. I shall attempt to sketch one such framework below. The reader is forewarned, however, that it is a highly fanciful conception but I hope will contain enough grains of truth to be considered of heuristic value.

Consider the following ways in which the environment is structured, and then note that the restrictions on how the environment is structured carries import for the possible identification of features which we as theorists may use to recognize and help define situational settings.

The earth and its physical environment into which we are born, grow up, and die is far from random. Indeed, for many phenomena, a remarkable periodicity constrains and relates one moment to the next. This is important to note because it is a sure bet that the evolution of life in the midst of these profound cyclic phenomena has been molded and is itself constrained by these external regularities. We seem so accustomed to these cycles that it seems necessary to force them back into conscious awareness by explicit mentioning.

Here are some of the physically determined cycles: day and night; fall, winter, spring, summer; rainy and dry seasons; high and low temperature periods. Each of the above has its immediate effects on behavior: day and night is correlated with brightness and darkness and also with warmth and cold. Seasons of the year are correlated again with warmth and cold and probably with degree of physical activity. Rainy and dry seasons influence not only our

immediate individual responses but can in a larger sense be the nucleus around which elaborate cultural ceremonies are performed--as in the Mayan religious ceremonies. But to implicate cultural patterns is to get too far ahead of ourselves at the moment.

A list of biological rhythms can also be mentioned which appear to be correlated with or influenced by some of the cyclic physical phenomena: being awake versus being asleep is cyclic; the cycle of birth, life, and death is another; then there is the monthly menstrual cycle in women; cyclic eating periods; periods of sexual arousal; breathing--all have a cyclic rhythm.

To return now to the cultural import of cycles, there are a number of cyclic social phenomena which may have been instigated by or had their inspiration from modeling after rhythms discovered in nature. Some of them are weekend rest periods; summer vacations; elections every four years rather than randomly selected times; yearly scheduled professional meetings; and on a more serious note, it has even been suggested that there seems to be a periodicity to the occurrence of war and peace.

A number of the above events may not be a simple function of time, but a good number are. Be that as it may, you may ask, what has all this to do with the particulars of infant growth and the particulars of perceiving situational contexts. I think it may have a great deal to do with it. In addition to the effects of the large-grained events mentioned above, it appears that a very fine-grained cyclic schedule is set up in many homes which varies in its pattern from household to household and also varies as a function of the age and number of children in the household. Some mothers may establish a highly rigid schedule of <u>daily</u> activities into which the infant or child becomes enmeshed. She may get up and wash at a certain hour, fix breakfast at a certain time, wash

dishes, iron, etc. all the while carting the infant or child about with her for many of these activities. This schedule may repeat day in and day out with minor variations. Other mothers or primary caretakers may establish a weekly routine so that the cycle clearly repeats only at weekly intervals. What effect does this great regularity have for the developing infant? It must form the backdrop of security and predictability that become preconditions for manipulating the objects around oneself and venturing out on one's own. A highly unpredictable world (both physically and socially) would hardly be conducive to encouraging a frail infant to become adventuresome. Regularly repeating events tend to induce not only a sense of security but also a sense of boredom and this in turn can provide the impetus for active exploration of the immediate environment.

Situational contexts may, in this regular cyclic world, become consciously perceived through the occurrence of minor variations in formats that occur in the daily or weekly schedule of events. That is to say, minor violations of expectancy help to focus attention on the source of the disturbance and in so doing provide a precondition for forming conscious schema of situational occurrences. It is known that expectancies can be set up quite quickly even in young infants (see especially Freedle, 1971; Lewis & Baumel, 1970); these same studies also indicate that violations of these expectancies lead to increased attention. What is being suggested here is that similar kinds of expectancies operate outside the controlled laboratory setting and this is especially true for those expectancies which have a cyclic patterned basis, be they physically or socially determined. When such violations in expectation occur I further speculate that in addition to the increased immediate attention which the organism pays to its immediate surroundings, the necessary conditions have also been established for the discovery of an integrated entity called 'situation.'

Let me give an example. Suppose that in household x the grandmother typically stops by at one o'clock for a daily chat. This social situation (visit by grandmother) begins with an explicitly marked entry point--the grandmother knocks on the door and calls out "It's me." (Many socially defined situations I believe have explicitly marked entry and exit cues precisely because these situations are under the direct control of knowledgeable humans--situations which depend upon physical cycles may not have such clear-cut entry and exit cues.) Further suppose that the grandmother picks up the infant, drinks a cup of coffee, and then leaves. This is the typical flow of events which define the situation "visit by grandmother." Suppose the infant has 'learned' a certain expectancy about this flow of events and suddenly one day the grandmother arrives, bursts into the room, has an argument with the mother, and then leaves. This violation of expectancy has at least two consequences for the infant: his heightened attention signals to him that something new has occurred and at the same time provides him with information that something old has been violated; it further provides him with information relevant to defining the beginnings and endings of a recognizable situation because the regular cyclic episodes in his 'typical' day have been violated only at a certain point in time (the point in time when the grandmother burst into the room) and ceased to be violated at another point in time (when the grandmother finally left). If the above reasoning is correct, then the expectancies that grow out of the experiencing of cyclic events also form the fabric out of which one segments the salient features of a situation--this latter segmentation being facilitated by experiencing violations in the typical flow of events.

As the infant gets older and moves into environments beyond the confines of his household he develops a somewhat different set of expectancies and a

more complex set of situational settings especially in the social realm of school settings, business settings, political settings, etc. In a wider sense, as one experiences the culturally permissible variations as to which situations can substitute for each other, then one's earlier schemata may accommodate to these sets of variants so as to reconceptualize at a more flexible level the critical features of situations. From a developmental perspective, there is probably survival value in being able to increasingly conceptualize the flood of detail of experience at a more general level--that of situations. Perceiving the world as a sequence of situations, some of which run their expected course while others get interrupted momentarily, helps to chunk and integrate the millions of pieces of raw data into manageable cognitive portions.

To summarize this second point, I have attempted to argue that developmental theory should attempt to incorporate the perceptual and dynamic aspects of situational recognition as an important and previously neglected aspect of developmental theorizing. In addition it has been argued that a straightforward mechanistic approach to defining situations and their perception must be modulated by a consideration of what the organism's momentary goal and purposes are. Thus the notion about having specific 'knowledge' of situations as one develops and moves into new environments must be modulated by considerations of a more dynamic system which parses and identifies relevant aspects of situations as a function of current momentary goals.

Task requirements and subject capabilities. A third major ingredient of developmental theory should in my opinion be one which attempts to define the obligatory and optional features of some externally defined task--such as tasks found in experiments, or tasks which a parent poses for his child, or errands or household duties that the parent requires the child to do. Notice

that in talking about 'tasks' one should allow for some task to be totally optional in its requirements in the sense that the child may define for himself what he wants to do with some object. It should also be pointed out that the requirements of a task are flexible and subject to redefinition as a function of the situation in which the task is performed. Thus if a child is alone he may impose no obligatory features on what he does with the task; similarly, if the child is playing with an object in the vicinity of an inattentive adult, no obligatory features may be imposed on manipulating the object. However, if the adult suddenly gets interested in what the child is doing, the manipulation of the object may acquire some obligatory features due to the insistent monitoring of the attentive adult. As another example an inquisitive scientist may impose many more obligatory or challenging features to the manipulation of the same object than any attentive parent might think of. I mention this simply to point out that there is always a dynamic and flexible set of criteria which are to be discerned in trying to characterize what the obligatory and optional features of task performance are--clearly, I have suggested that the set of obligatory and optional features is or can be a function of the social and situational setting.

After a task description and task requirements have been settled upon for a given circumstance, we also wish to delimit how these requirements mesh with the child's information-processing capabilities. How many relational structures can he hold in memory so as to unite them into a resultant? How many dimensions can he "sample" at one time and is this adequate to the demands of the task? How many "actions" can he perform together or in sequence and are these limitations within an acceptable range to get a correct score on the task? If his capabilities fall just short of the current task requirements, do we wish to invoke some

probability ideas to indicate how many times out of 100 he will get the task correct? Some of these questions can be approached in a more systematic fashion by assuming that a certain subset of tasks consist of dimensionalized features with one or more values on each of the dimensions. One can then inquire which dimensions the child is capable of processing and interpreting as he gets older; presumably, the number of dimensions that one can process increases as one matures, and also, the number of these dimensions that can be dealt with simultaneously (in multiplicative fashion) increases with maturity. To introduce situational context, one can speculate that the dimensions of a task that are likely to be sampled (i.e., that are regarded as obligatory by the subject) and processed may be a function of the context. Thus if we are asked to find novel uses for a toy, this context may predispose us to examine dimensions of the toy that we otherwise would ignore.

One can see that at the level of task description and subject capabilities, the three themes of this paper come together: obligatory and optional features of tasks are viewed as functions of the immediate contextual situation; furthermore, probabilistic aspects of success in task completion may enter in when a mismatch between a subject's dimensional capabilities and task requirements occur.

A more formal theory which weaves these ingredients into a detailed account of cognitive capabilities and cognitive perceptions which have testable consequences may eventually take the form of an elaborate computer program much in the spirit of Newell and Simon's (1972 theory. Thus one can well envisage a master program that consists of 'task' goals as a function of situational indices which serve to integrate and motivate complex sequences of behaviors towards some concrete objective--remember, we allow for the possibility that for

young children, the 'task' objective may totally consist of optional features. The master program would also contain information regarding structural changes which occur as the child matures through interaction with his social and physical environment. These structural changes might be at the level of relational knowledges which the child has acquired, for example, through discovery of situational invariances. As the dimensional sampling capability of the child increases, the rate at which situational invariances can be discovered may increase. Similarly as dimensional capacity increases the ability of the subject to hold fast to a situational goal may improve--thus, the probability of distractibility from some momentary goal may decrease with age simply because the subject now has sufficient dimensional "computer space" so that he seldom loses track of this relevant piece of information in guiding his more molecular subroutines of behavior. Another aspect to this overall master program may incorporate assumptions regarding the degree to which conscious monitoring of molecular behaviors occurs as a function of maturity levels. Thus a young child who may be said to be in a sensorimotor stage may use all his available conscious "computer space" for sequencing his motor movements in interaction with the environment. Later in learning, the subroutine which handles sensorimotor coordinations may not be consciously monitored, with the consequence that the "computer space" previously taken up by monitoring these more molecular behaviors is free now to deal with bigger chunks of the environment, such as monitoring the situational network and closeness to the total task goal. The ambitiousness of the above enterprise suggests that we may be quite far from a true theory of development which cannot only provide detailed and accurate descriptions of current behaviors of a child at various age levels, but at the

same time, can make interesting and perhaps startling predictions about observable behaviors of which we were not previously aware. At least, a good theory should be capable of doing this. For the moment, we may have to content ourselves with less ambitious theories until such time as we can agree upon a small but combinatorially productive set of developmental axioms out of which a more inclusive theory can be constructed.

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